CLAIMS

What is claimed is:

1. A package with an integral window for housing a microelectronic device, comprising a monolithic multilayered body with an integral window; wherein the body comprises:

a first sub-stack comprising at least one layer of an electrically insulating multilayered material, a first aperture disposed through the first sub-stack, and a first electrical conductor disposed on the top surface of the first sub-stack;

a second sub-stack comprising at least one layer of the electrically insulating multilayered material, a second aperture disposed through the first sub-stack, and a second electrical conductor disposed on the top surface of the second sub-stack;

a third sub-stack comprising at least one layer of the electrically insulating multilayered material and a third aperture disposed through the third sub-stack; and

an integral window disposed across the first aperture;

wherein the second sub-stack is stacked on top of the first sub-stack, and the third sub-stack is stacked on top of the second sub-stack;

wherein the third aperture is wider than the second aperture;

wherein the second aperture is wider than the first aperture; and

wherein the integral window is bonded directly to the body without having a separate layer of adhesive material disposed in-between the window and the body.

2. The package of claim 1, wherein the window is bonded directly to a lip recessed inside of the body.

3. The package of claim 1, wherein the geometrical relationship between the window and the body comprises an encased joint geometry.

4. The package of claim 1, wherein the geometry of the outer edge of the window comprises a self-locking geometry selected from the group consisting of a tapered outer edge, a convex rounded outer edge, and a chevron-shaped double-tapered outer edge.

5. The package of claim 1, wherein the window is disposed on the bottom surface of the first sub-stack and extends laterally along the bottom surface of the first sub-stack a sufficient distance beyond the periphery of the first aperture to provide a sufficiently large overlapping area to provide a sufficiently high bond strength.

6. The package of claim 1, wherein the window substantially fills the aperture.

7. The package of claim 6, wherein the window is formed by casting a castable window material directly into the aperture.

8. The package of claim 7, wherein the castable window material comprises a molten glass that has solidified after casting or a transparent liquid polymer that has hardened after casting.

9. The package of claim 1, wherein the window comprises an optically transparent material selected from the group consisting of glass, sapphire, fused silica, clear plastic, and clear polymer.

10. The package of claim 1, wherein the window comprises a material selected from the group consisting of silicon, germanium, metal, metal alloy, lithium niobate and lithium tantalate.

11. The package of claim 1, wherein the window comprises a material selected from the group consisting of barium fluoride, calcium fluoride, lithium fluoride, magnesium fluoride, potassium fluoride, sodium chloride, zinc oxide, and zinc selenide.

12. The package of claim 1, wherein the window comprises an anti-reflection coating.

13. The package of claim 1, wherein the window comprises means for filtering selected wavelengths of light.

14. The package of claim 1, wherein the window further comprises a lens for optically transforming the light that passes through the window.

15. The package of claim 1, wherein the window further comprises an array of binary optic lenslets for optically transforming the light that passes through the window.

16. The package of claim 1, wherein the multilayered material comprises a low-temperature cofired ceramic material fired at a temperature from about 600 C to about 1000 C.

17. The package of claim 1, wherein the multilayered material comprises a high-temperature cofired ceramic material fired at a temperature from about 1300 C to about 1800 C.

18. The package of claim 1, wherein the multilayered material comprises a polymer-based printed wiring board material.

19. The package of claim 1, wherein at least one electrical conductor comprises a thick-film metallized trace.

20. The package of claim 1, wherein at least one electrical conductor comprises an electrical lead.

21. A package with an integral window for housing a microelectronic device, comprising:

a monolithic body, comprising a electrically insulating multilayered material; the body having a bottom surface, an opposing top surface, a stepped aperture disposed through the body, and at least two interior ledges;

a first electrical conductor disposed on the first interior ledge;

a second electrical conductor disposed on the second interior ledge;

an integral window disposed across the aperture and bonded directly to the body without having a separate layer of adhesive material disposed in-between the window and the body; and

a first microelectronic device flip-chip interconnected to the first electrical conductor on the first interior ledge.

22. The package of claim 21, wherein the first microelectronic device comprises a chip selected from the group consisting of a semiconductor chip, a CCD chip, a CMOS chip, a VCSEL chip, a laser diode chip, a LED chip, a MEMS chip, and a IMEMS chip.

23. The package of claim 21, wherein the first microelectronic device comprises a light-sensitive side facing the window.

24. The package of claim 21, further comprising a polymer underfill encapsulating at least one of the flip-chip electrical interconnections.

25. The package of claim 21, further comprising a continuous ring seal disposed in-between the first microelectronic device and the body.

26. The package of claim 25, wherein the atmosphere in-between the window and the ring seal comprises a dry inert gas other than air, selected from the group consisting of argon, nitrogen, and helium, and combinations thereof.

27. The package of claim 21, further comprising a second microelectronic device, mounted back-to-back to the first microelectronic device.

28. The package of claim 27, wherein the second microelectronic device is wirebonded to the second electrical conductor.

29. The package of claim 28, wherein the wirebond and the pair of microelectronic devices are substantially encapsulated in a polymer-based encapsulant, except for any light-sensitive surfaces.

30. The package of claim 29, further comprising an opening in the polymer-based encapsulant for providing open access to the front side of the second microelectronic device.

31. The package of claim 30, wherein the opening in the polymer-based encapsulant is defined by a dam that encircles at least some of the front side of the second microelectronic device, which prevents any encapsulant from occluding the front side of the second microelectronic device during encapsulation of the wirebond.

32. The package of claim 21, further comprising a wirebond interconnect made from the backside of the first microelectronic device to the second electrical conductor on the second interior ledge.
33. The package of claim 32, wherein the wirebond interconnect and the backside of the first microelectronic device are substantially encapsulated in a polymer-based encapsulant.
34. The package of claim 21, further comprising a cover lid attached to the top surface of the body for sealing the package.
35. The package of claim 34, wherein the cover lid is attached to the body with a material selected from the group consisting of a hermetic sealant and a polymer-based adhesive.
36. The package of claim 34, wherein the cover lid is transparent.
37. The package of claim 34, wherein the cover lid comprises a window.
38. The package of claim 34, wherein the atmosphere inside the sealed package comprises a dry inert gas other than air, selected from the group consisting of argon, nitrogen, and helium, and combinations thereof.
39. The package of claim 21, further comprising a second microelectronic device flip-chip bonded to the second conductor on the second interior ledge.
40. The package of claim 28, wherein the body further comprises a third electrical conductor disposed on a third interior ledge, and further wherein the second microelectronic device has a wirebond interconnection to the third electrical conductor.
41. The package of claim 23;

wherein the package is mounted on, and is electrically interconnected to, a printed wiring board;

wherein the printed wiring board comprises an opening through the board; and

wherein the aperture in the package is aligned with the opening in the printed wiring board, thereby allowing light to pass through both the opening and the

aperture to interact with the light-sensitive side of the first microelectronic device.

42. A method of fabricating a package with an integral window for housing a microelectronic device, comprising:

a) personalizing at least three sub-stacks of individual layers of an electrically insulating multilayer material by removing a cutout shape from each layer; and by depositing a first electrical conductor on the top layer of the first sub-stack; and by depositing a second electrical conductor on the top layer of the second sub-stack;

b) stacking and registering the at least three sub-stacks of individually personalized layers, including placing a window at a specified location in the first sub-stack, to make an assembled stack of sub-stacks;

wherein the assembled stack comprises a stepped aperture disposed through the stack, wherein the stepped aperture comprises a first interior ledge and a second interior ledge;

wherein the window is disposed across the stepped aperture;

wherein the first electrical conductor is disposed on the first interior ledge; and

wherein the second electrical conductor is disposed on the second interior ledge; and

c) processing the assembled stack by applying sufficient pressure and elevated temperature to the assembled stack for a sufficient time to form a consolidated monolithic multilayered body having an integral window;

wherein the window is bonded directly to the body without having a separate layer of adhesive disposed in-between the window and the body.

43. The method of claim 42, wherein the multilayer material comprises a low-temperature green ceramic tape; and further wherein the processing step c) comprises laminating the assembled stack into a rigid block and then cofiring the laminated block at a temperature from about 600 C to about 1000 C.

44. The method of claim 42, wherein the multilayer material comprises a high-temperature green ceramic tape; and further wherein the processing step c) comprises laminating the assembled stack into a rigid block and then cofiring the laminated block at a temperature from about 1300 C to about 1800 C.
45. The package of claim 42, wherein the multilayered material comprises a polymer-based printed wiring board material.
46. The method of claim 42, further comprising, after step c), flip-chip bonding a first microelectronic device to the first electrical conductor on the first interior ledge.
47. The method of claim 46 further comprising flip-chip bonding a second microelectronic device to the second electrical conductor on the second interior ledge.
48. The method of claim 46, wherein the first microelectronic device comprises an unreleased MEMS structure protected by a sacrificial layer; and further comprising releasing said unreleased MEMS structure by removing said sacrificial layer after the first microelectronic device has been flip-chip interconnected to the body.
49. The method of claim 48, wherein the sacrificial layer comprises parylene.
50. The method of claim 46, further comprising applying a polymer underfill in-between the first microelectronic device and the body to form a continuous ring seal.
51. The method of claim 46, further comprising applying a polymer encapsulant to encapsulate the first microelectronic device and its electrical connections.
52. The method of claim 46, further comprising attaching a cover lid to the body to seal the package.
53. The method of claim 46, further comprising attaching a second microelectronic device back-to-back to the first microelectronic device and then wirebonding the second microelectronic device to the second electrical conductor on the second interior ledge.

54. The method of claim 42, further comprising:

providing a pair of first and second microelectronic devices bonded together back-to-back, and then;

after step c), flip-chip bonding the first microelectronic device with attached second microelectronic device to the first electrical conductor on the first interior ledge; wherein the first microelectronic device has a light-sensitive side facing the window; and

then wirebonding the second microelectronic device to the second electrical conductor on the second interior ledge.

55. The method of claim 54, further comprising applying a polymer underfill in-between the first microelectronic device and the insulating body to form a continuous ring seal.

56. The method of claim 54, further comprising applying a polymer encapsulant to encapsulate the first and second microelectronic devices, and the flip-chip and wirebonded electrical interconnections.

57. The method of claim 54, wherein the second microelectronic device comprises a second light-sensitive area with a dam encircling said second light-sensitive area, and further comprising applying a polymer encapsulant in-between the dam and the body to encapsulate the wirebond, while not occluding the second light-sensitive area.

58. The method of claim 42, further comprising attaching to the body a first exterior electrical lead connected to the first electrical conductor; and attaching to the body a second exterior electrical lead connected to the second electrical conductor.

59. The method of claim 42, further comprising depositing a metal or metal alloy coating onto the outer edge of the window prior to bonding the window to the body.

60. A method of housing a microelectronic device in package with an integral window, comprising:

a) providing the package of claim 1;

b) providing a first microelectronic device having a light-sensitive side; and

c) flip-chip bonding the first microelectronic device to the first electrical conductor, wherein the light-sensitive side of the first microelectronic device faces the window.

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